Energy & Environmental Security

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AF Minerva Initiative Goals

- Outreach - linking AF scholars to DoD programs on EES and world-wide community of scientists, researchers, and policy makers, particularly those associated with NATO partner countries
- Research - promoting unique and innovative research on EES to help identify and guide AF policy, strategy and operations as well as assisting partnership building
- Curriculum Development – producing education plan that promotes meaningful learning objectives and integrates EES themes in existing PME

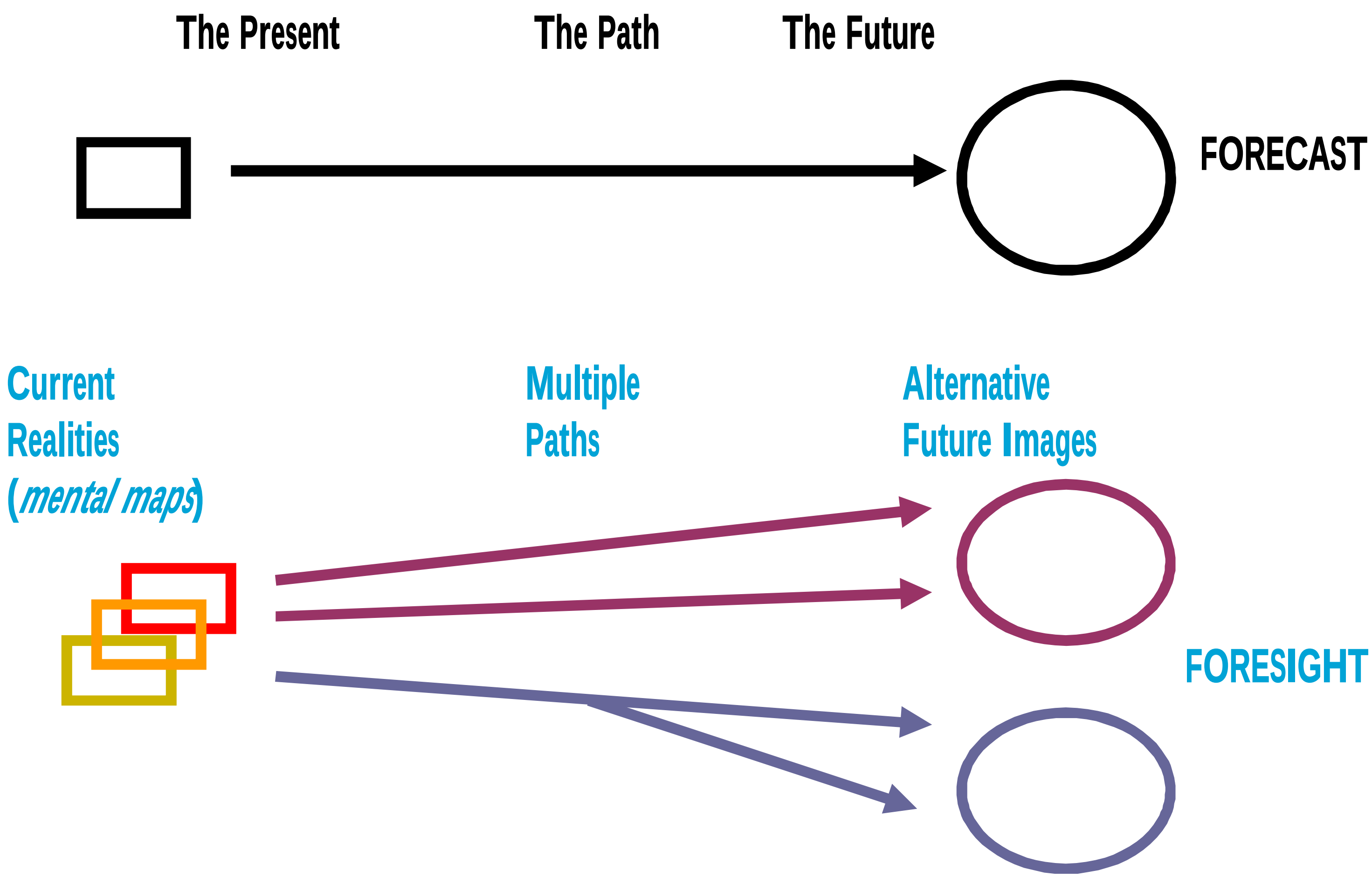
Current projects

- NATO scenario planning: long range energy and environmental security scenarios for NATO HQ/ACT/SHAPE
- Asia-Pacific security: comprehensive energy & environment assessment for USAF Chief of Staff, including Japan, India and China
- PACOM disasters: scenario risk planning process to support pre-planning in US Pacific Command

Definition of surprise attack **(from Kam 1988)**

- An event that is disproportionately damaging
- Was not anticipated
- Indicates underlying unpreparedness

Forecasts versus Foresight



Source: Scottish government

Net Assessment

- Net assessment refers to a combination of:
  - Capabilities analysis
  - Response assessment
  - Vulnerability assessment
- Just how extreme can environmental systems become?
- What vulnerabilities are at risk?
- What resources are available to respond?

Scenario typologies

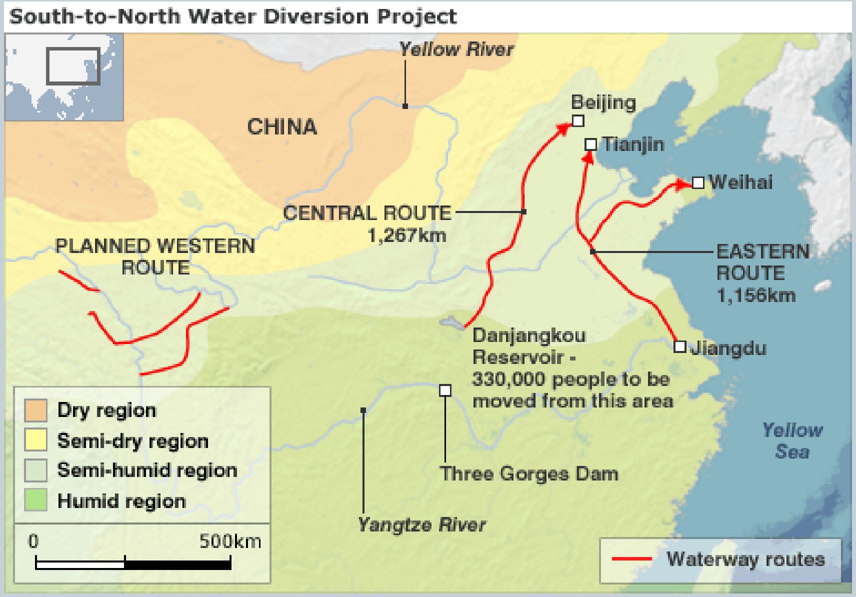
- Standalone scenario with environmental change as a central focus.
- Insertion of layer that complicates strategic or operational risks.

Energy-water nexus

- Most energy production requires large amounts of water
  - Or too much water can threaten supplies: Katrina or Fukushima
- Colorado River water in Los Angeles requires 2000kWh per megaliter
- 1000 MWe reactor (20°F ΔT) requires 3 megaliters of water per minute

Link to Chinese security

- Development in northern China (Yellow River basin) requires large amounts of water
- South-North project from Yangtze to Yellow
- Logically may also require diversion from Yarlung-Tsangpo
- Diversion of water from Brahmaputra into India and Bangladesh



Source: BBC

Understanding security implications

- Responses to environmental/energy risks may be misinterpreted as security threats
  - Context of India/China border disputes in Arunachal Pradesh
  - Intentions versus impacts
- Risk assessments must include perceptions
  - Cascading impacts and feedbacks
- Focusing on 'most probable' may underestimate risks
  - Disasters as improbable combinations of probable events

Challenges I

- **Scalability**: how do we take global processes and determine local/regional impacts?
- How do we then scale back to the global?
- Example: global shifts in atmospheric energy budgets (aka climate) may result in monsoon disruption.
  - What impacts does this have on Egypt/Pakistan/India?
  - How do those local impacts affect security concerns internationally?
  - Answers the question of why we should care about a far away place about which we know nothing.

Challenges II

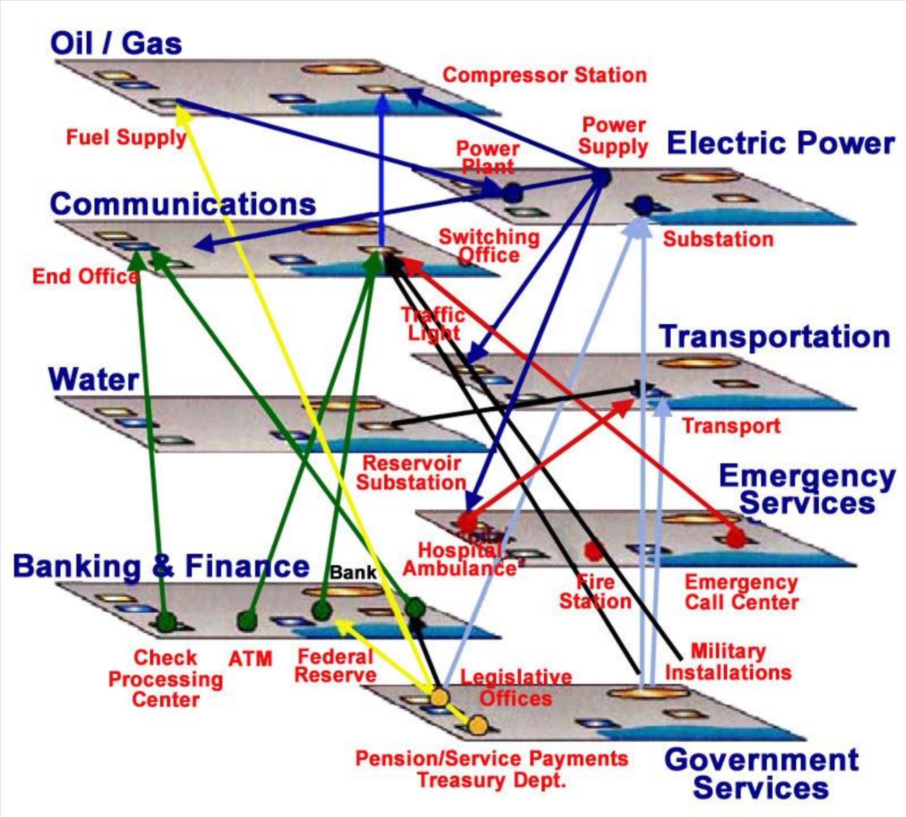
- **Legibility**: How do data sets and concepts from one area translate into other areas?
- Example: In describing potential impacts from environmental changes, how do oceanographers, glaciologists, atmospheric scientists, sociologists, engineers, etc speak and work in a common framework?
- Example: disconnect between human security and state security

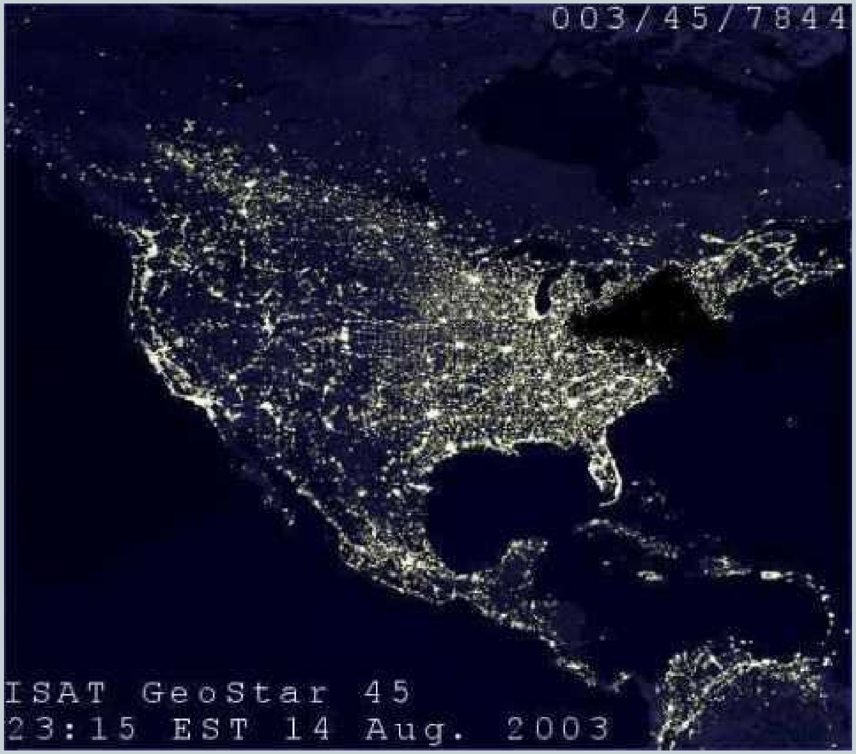
Challenges III

- **Transparency**: How does scientific work maintain its essential nature when working in a security organization?
- Example: How do intelligence or military officers gain information from foreign scientists?
- What happens to the information after it is collected?
- Not all open-source information is available. Example of methane hydrate emissions from Barents Sea, and the role of the drunken researcher.

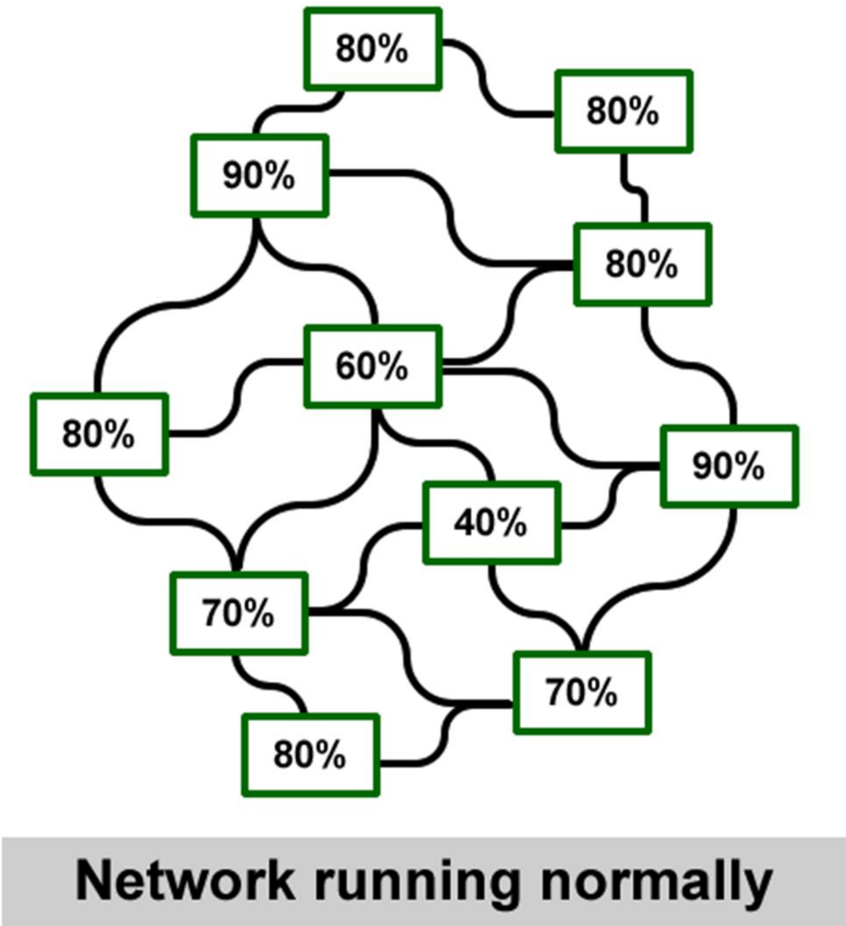
Challenges IV

Infrastructure vulnerabilities





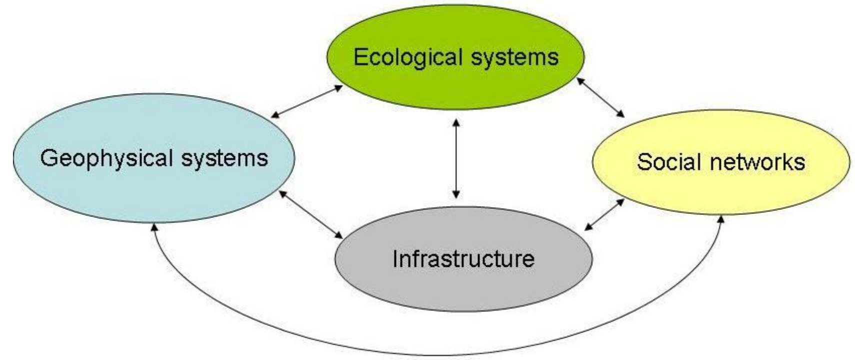
Critical nodes, cascading failures



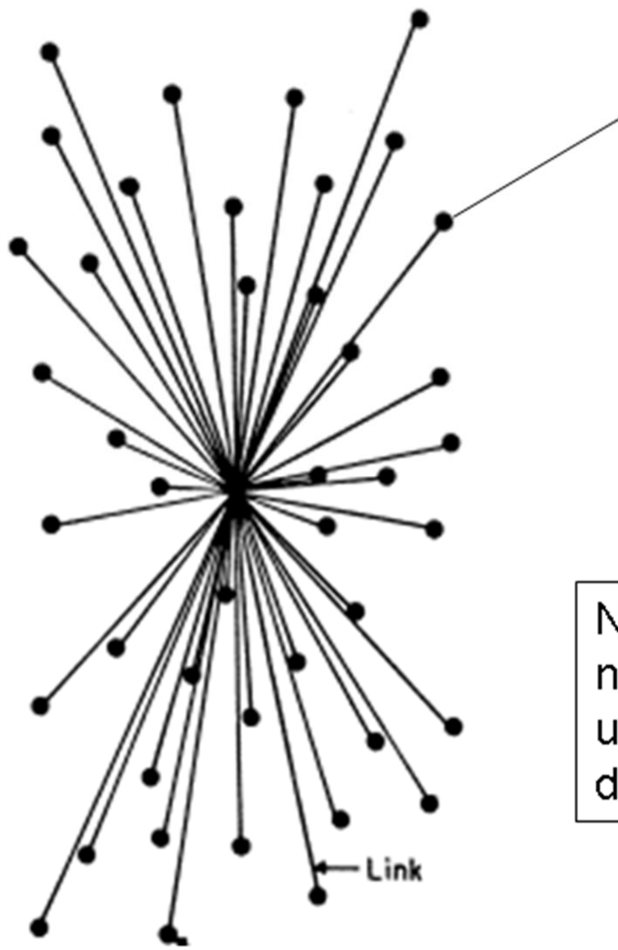
- Changes to one area may spread to others
- Relationships matter
- Intervention can make things worse

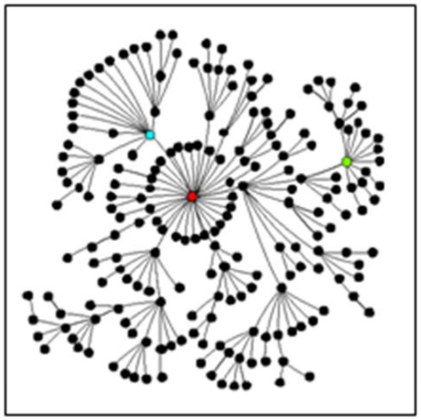
Graphic: WikiCommons:Stickulator

Topologies



- Identifying critical nodes & vulnerabilities
- Cascading effects between systems
- Common language for researchers





Nested scale-free social networks dependent upon centralized water distribution network.

Translation to security

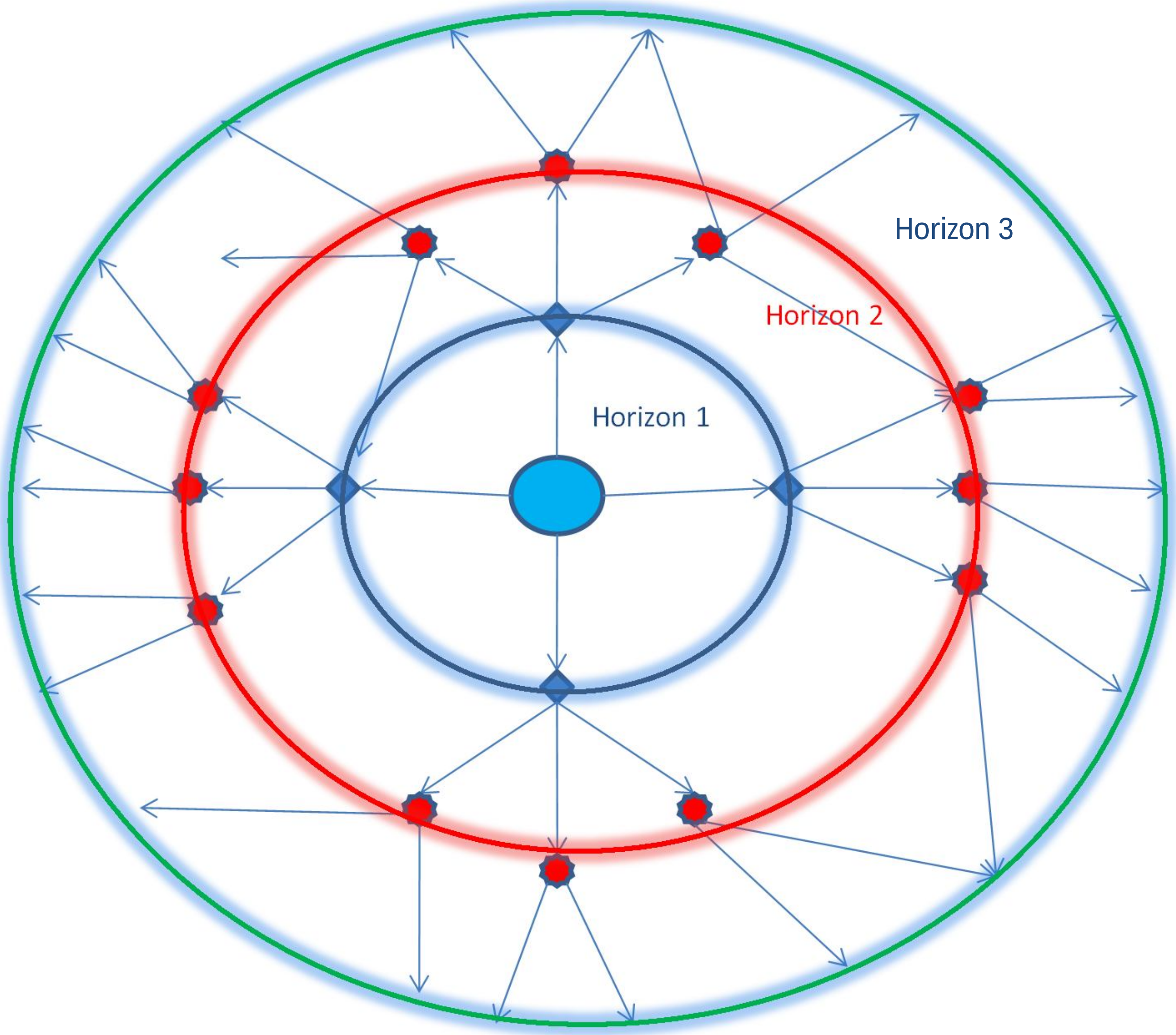
- Scenario sets are pretested for potential application
  - (This is inherently subjective and political)
  - Criteria: visibility, impact, certainty
  - Simple run-throughs by expert teams

Tyson's Corner, VA, Dec 2008

Connecting the dots

- Selected scenario points are then plotted for first, second and third-order impacts
  - Including feedback effects
  - Identification of critical uncertainties and vulnerabilities
  - Distributed expert networks are used to help plot and guide potential pathways
  - Key: how will systems react and adapt to changes?

Cascading impacts from discreet geophysical events



USAF/FOI

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Methodological outline

First, some definitions:

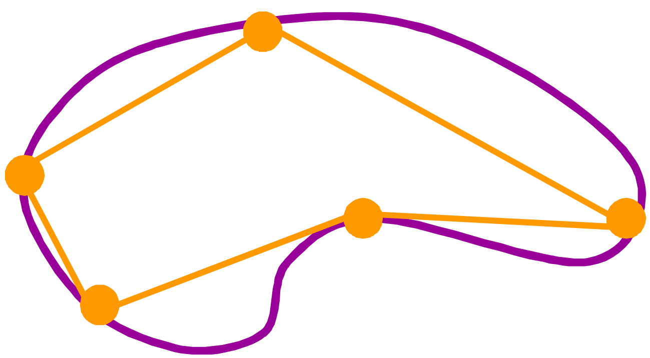
- ***Variable*** **(environmental drivers): Dimensions of uncertainty**
- ***State*****: Each variable is assigned a number of states**
- ***Scenario*****: One state for each variable (e.g. red, blue)**

Variables

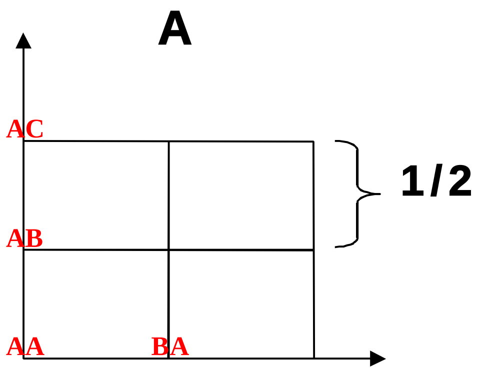
V_1	V_2	V_3	V_4
S_1^A	S_2^A	S_3^A	S_4^A
S_1^B	S_2^B	S_3^B	S_4^B
S_1^C	S_2^C		S_4^C

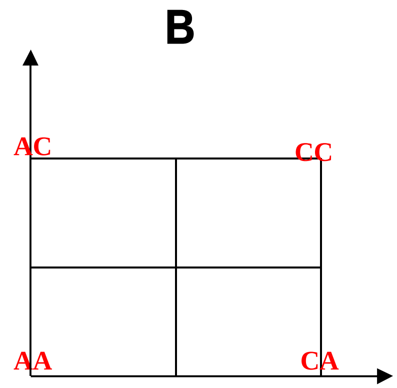
States

Task: Find the scenario set that maximally span the state space.



A simple example in two dimensions:





For figure A we get:

$D_{min} = ½$,

$D_{aver} = (D(AA, AB) + D(AA, AC) + D(AA, BA) + D(AB, AC) + D(AB, BA) + D(AC, BA))/6$

$= (½ + 1 + ½ + ½ + 1 + 3/2)/6 = 5/6$,

and for figure B:

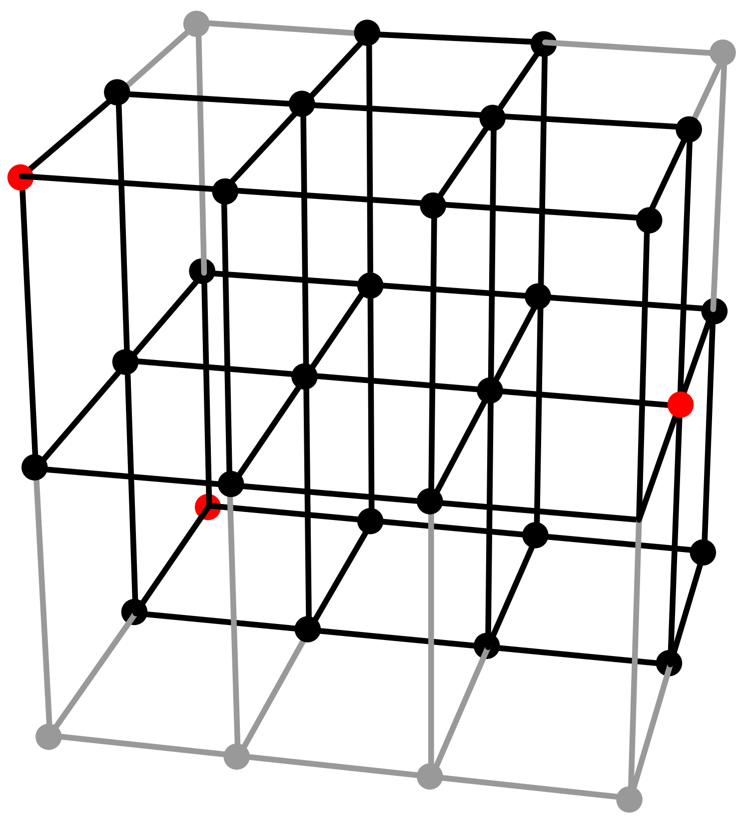
$D_{min} = 1$,

$D_{aver} = (D(AA, AC) + D(AA, CA) + D(AA, CC) + D(AC, CA) + D(AC, CC) + D(CA, CC))/6$

$= (1 + 1 + 2 + 2 + 1 + 1)/6 = 4/3 > 5/6$.

A simple example of a 'maximally' spanning set

In this simplified example the scenario space consists of only three variables with 4, 3 and 3 states respectively. Out of the 36 theoretically possible scenarios 6 have been deemed infeasible (light-grey points). Then the red points are a set of three maximally different feasible scenarios.



In higher dimension this is very tricky. We have therefore developed a supporting software tool.